TERI Governing Council

Cover Picture
An artist's view of TISCO Works

This report has been prepared by G Sambasivan of TERI in consultation with the Energy and Economy Department of the Tata Iron & Steel Company Limited The information given in this report pertains only up to September 1988

FOREWORD

The Case Study series brought out by TERI has now developed a wide readership. This is a clear indicator of the growing consciousness among industrial managers, Government officials and others concerned with energy of the importance of energy conservation.

The studies brought out by TERI earlier dealt with large units in which success stories had been created through a blend of managerial and technical measures which provide a good example to emulate. The present Case Study dealing with Tata Iron & Steel Company Limited (TISCO) introduces a new dimension into our series, since it deals not only with a large integrated iron & steel company but also a unit which foresaw the importance of energy conservation in maintaining a position of competitiveness and high profitability. The most heartening feature of this exercise has been the help provided by the management of TISCO, or else the team of professionals from TERI would have spent far greater time in collecting and analyzing information. The Case Study brings out the importance of co-ordination at the top and the setting up of clear targets and objectives at the level of the Company which then translate into specific steps at the departmental level. Such an approach necessarily comes from a managerial philosophy that is deeply ingrained in the minds of all personnel in the organization. As the Case Study mentions, energy conservation has been a way of life at Tata Steel for well over half a century. It is only with this philosophy and the commitment already existing in the Company that specific energy consumption was brought down by 23.5% during the last decade, which reflects an annual rate of reduction of 2.14%. Translated into financial benefits, the reduction achieved during the last five years itself amounts to a total saving of Rs. 358.8 million.

This Case Study is more extensive than previous publications in the series. The size of this publication necessarily reflects the complexity of the operations of an integrated iron and steel unit and the following pages bring out how the efforts in different units and departments of the organization complement each other in producing remarkable results at the level of the Company. It is hoped that this Case Study would provide further inspiration to those who see the rationale and the inevitability of improving energy efficiency in India's industrial sector. It would be no exaggeration to state that in the immediate future, given the constraints of capital and energy supply, the industrial progress of this country depends largely on attaining higher energy efficiency in the industrial sector.

R.K. Pachauri
Director
Tata Energy Research Institute
New Delhi

About TISCO

The modern steel industry in India owes its birth to Jamshedji Tata The establishment of the first integrated steel plant at Jamshedpur in 1911 by the Tata Iron and Steel Company Limited (TISCO) was the beginning of a new era (See Box A for History of Steel Industry in India) Jamshedpur is located in the state of Bihar near Calcutta The production in 1911-12 was approximately 1,000 tonnes of saleable steel, 37,000 tonnes of hot metal and 3,000 tonnes of ingot steel Over the years, Tata Steel has developed into a large modern steel plant with some of the most modern methods of steelmaking processes and equipment There exists a drive towards efficiency in all operations of the steel plant, and especially with respect to energy consumption

Products, Licensed and Installed Capacities, and Production

TISCO produces a wide range of steel products such as continuous weld tubes, seamless tubes, alloy steel, ball-bearing rings, bearings and ferro-manganese steels The licensed and installed capacities and production for 1986-87 are shown in Table 1

Table 1. Licensed and installed capacities and production of steel and steel products during 1986-87*

(million tonnes)

Product Name	Licensed Capacity	Installed Capacity	Production
Saleable steel	2,100,000	1,740,000	1,907,309
Ferro-manganese steel	30,500	30,500	24,084
Continuous weld tubes	176,793	175,000	60,906
Cold rolled strips	13,300	15,800	10,599
Electric resistance weld tubes	18,000	18,000	9,497
Seamless tubes	55,000	52,000	31,358
Carbon and alloy steel bearing rings, annular forgings and flanges	5,250	5,250	410
Alloy steel ball bearing rings	20,500,000	20,500,000	4,538,451
Bearings	8,000,000	3,890,000	3,604,429

* Excluding items intended for captive consumption
Source TISCO Eightieth Annual Report, 1986-87

Continued improvement in the operations of the Company resulted in a record output of gross saleable steel of 1 907 million tonnes (Mt) equivalent to 110 per cent of the annual rated capacity After adjustments for transfers to the Tubes Division, the net saleable steel output during the year was 1 862 Mt, as shown in Table 2

Table 2. Production of intermediate and final products during 1986-87

Product	Quantity (Mt)
Coke	1 419
Iron	1 940
Liquid steel	2 250
Saleable steel	1 862

The overall proportion of semi-finished steel produced was 59 per cent in 1986-87 The proportion of tested steel production was 88 7 per cent in 1986-87, an all-time high

Modernization

A major facility under the continuing Modernization Programme, viz a 300,000-tonne capacity Bar and Rod Mill, was commissioned in March 1987 Another important facility known as the Waste Recycling Plant (WRP), which will enable increased recovery of iron-bearing materials from waste, was commissioned in October 1986 Various other facilities to increase the Steel Works capacity to 2 10 Mt of saleable steel from the existing 1 74 Mt are under implementation

Expansion Plans

Tata Steel has been actively pursuing the Government of India's suggestion that by the mid-1990s, through a continual process of modernization, it should add another million tonnes to its present installed capacity by adopting latest steelmaking process technologies, viz Linnz and Donnevitz (LD) furnace, continuous casting (CC) and energy optimizing furnace (EOF) along with support units, a one-million tonne hot strip mill, etc

Energy Scene

Steelmaking is an energy-intensive operation At every stage in steel production, from cokemaking for the blast furnace charge to finished steel product, a large quantity of thermal energy is consumed In addition, considerable electrical energy is required, though it is much smaller in proportion to the thermal energy

BOX A

History of Steel Industry in India

teel in Ancient India

he Indian iron ore deposits, which are among the nest and the largest in the world, have been worked for illennia It is believed that some of iron and steelmaking i India dates back to over 2500 years, placing India mong the earliest users of iron and steel in the world

he most famous product of our ancient iron workers is ie famous pillar near the Kutab Minar in Delhi, now ated about A D 300 This pillar is remarkably free of ıst Over 7-m high and weighing approximately six ›nnes, this extraordinary pillar is not a casting, but was uilt-up by welding discs of forged iron together It is a roof of the incomparable skill of the early Indian ietallurgists

et another significant achievement was the manufacıre of wootz steel, which was exported over a thousand ears ago and which gave the blades of Damascus their liancy, strength and elegance

Iodern Steel Industry

'he first significant attempt at manufacturing iron with oke as fuel for smelting took place in the Bengal Iron Vorks Company at Kulti in 1875

'he history of steel industry in India may be divided into hree distinct phases The first phase began with the etting up of a steel plant at Jamshedpur in 1907 by amshedji Tata The Indian Iron and Steel Company [ISCO) of Burnpur in West Bengal was established in 918 In 1936, the Bengal Iron Works Company merged vith IISCO Another small plant at Bhadravathi in Karnataka was set up in 1923 Before independence ndia had a steel capacity of 1 5 million tonnes (Mt) In 948, the country's production was 1 254 Mt of ingot teel and 0 866 Mt of saleable steel

'he second phase began with the commencement of the ›econd Five Year Plan when a decision was taken by the Government to build three large public sector steel ›lants, each of one million tonne capacity They were to ›e erected at Rourkela, Bhilai and Durgapur

'he third phase marked the beginning of expansion of he then existing plants During the Second Plan period, was decided to expand the capacities of IISCO and 'ISCO to 1 Mt and 2 Mt respectively Thus, the Second 'lan witnessed the most striking progress in the developnent of steel industry, increasing the installed capacity rom 1 5 Mt to 6 Mt

All integrated steel plants with the exception of TISCO are in the public sector. In 1973, Steel Authority of India (SAIL) was formed as a holding company for all public sector steel plants Apart from the integrated steel plants, a significant amount of steelmaking capacity has also been established in mini steel plants Finished steel products are also manufactured by rerollers and cold rolling units

Role of Mini Steel Plants

Along with the integrated steel plants, the country witnessed the growth of secondary steel producers, who manufacture steel in electric arc furnaces, popularly known as mini steel plants By 1945 there were about 15 electric arc furnaces producing about 70,000 tonnes per year of steel casting and ingots and there were over 100 rerolling mills which consumed either rerollable scrap from railways/fabricating industries or billets as input materials

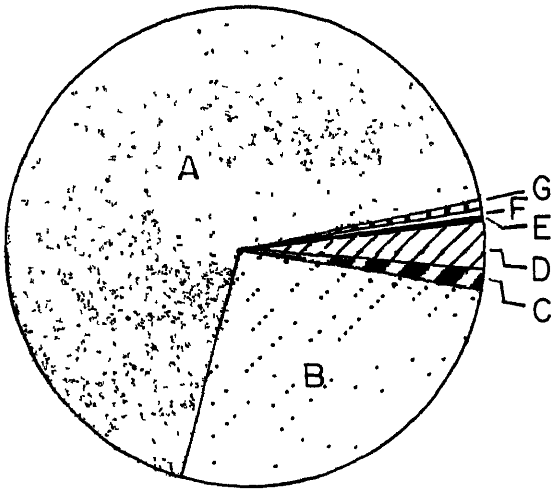
Steelmaking Capacity and Production

The all-India steelmaking capacity has increased to about 19 1 Mt of steel ingots per year Of this, the six integrated steel plants at Bhilai, Bokaro, Durgapur, Burnpur, Rourkela and Jamshedpur account for 14 72 Mt, considering Bhilai's and Bokaro's capacity as 4.0 Mt each

At present, there are 196 mini steel plants holding licences and letters of intents with a total capacity of 6 5 Mt of ingots/billets per year Out of these, 161 units with an annual installed capacity of approximately 4 37 Mt are in production

The total ingot steel production in the country in 1986-87 was 12 03 Mt, out of which 8.76 Mt were from the integrated steel plants The corresponding figures for saleable steel were 10 54 Mt and 8 22 Mt respectively

An integrated steel plant known as the Vishakhapatnam Steel Plant (VSP), with a capacity of 2.66 Mt of saleable steel, is being set up near Vishakhapatnam with some of the most modern facilities such as LD converters and continuous casting machines Stage I of this plant is expected to be on stream by the third quarter of 1988 At this point, VSP will be able to produce 1.5 Mt of liquid steel per annum



		10^6 Gcal	%
A.	Coking coal	14.440	70.03
B.	Steam coal	5.307	25.74
C.	Fuel Oil + LDO	0.187	0.91
D:	L.S.H.S	0.568	2.75
E.	Oxygen	0.019	0.09
F.	Purchased power	0.028	0.14
G.	High Speed Diesel Oil	0.071	0.34
	Total	20.620	100.00

Figure 1a Total energy input in various energy forms in TISCO during 1986-87 with crude steel production of approximately 2.25 Mt

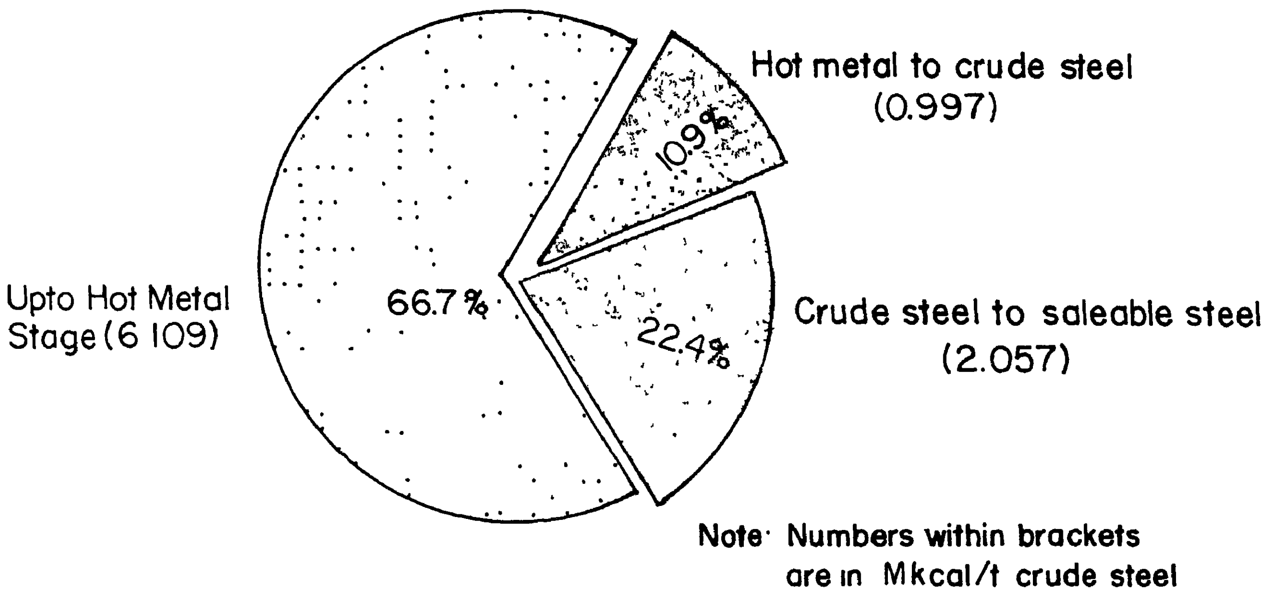


Figure 1b Stagewise specific energy consumption values in 1986-87

ntegrated steel plants in India have generally adopted the conventional blast furnace—open-hearth furnace (OH)—basic oxygen furnace (BOF)—ingot/continuous cast-rolling mill route for making steel (A simplified flowchart and a description of steelmaking are given in Box B) The process at TISCO is no exception to this process of making steel The open-hearth process still dominates the Indian steel industry unlike that in developed countries, where more than 80 per cent of steel production is through BOF—continuous casting route The specific consumption in Indian steel plants is between 9 and 12 Gcal/t crude steel, whereas in the developed countries it is about 5-6 Gcal/t of crude steel *

The average in-plant power generation reached 86 7 MW in 1986-87 The Company's captive collieries provided 1 99 Mt of clean coal and 0 394 Mt of coking coal was imported in the same year

Figure 1a shows the total energy input in various energy forms during 1986-87 Coking coal and steam coal contributed over 95 per cent of the total energy input to the plant and the rest was from furnace oil, light diesel oil, low sulphur heavy stock oil, high speed diesel oil, oxygen and purchased power The contribution from fuel oils is 4 per cent of the total energy input

Figure 1b shows the stagewise specific energy consumption values for the production of hot metal, crude steel and saleable steel About two-thirds of the energy input has gone into the production of hot metal from basic raw materials Up to the crude steel stage, the specific energy consumption accounts for approximately 78 per cent

The net energy used in the plant in 1986-87 was equivalent to $20\ 62 \times 10^6$ Gcal, which is equivalent to 2 062 Mt of oil The total cost of energy was Rs 2,132 million

Energy Conservation

At Tata Steel, energy conservation has been a way of life for well over half a century Efforts towards energy conservation were greatly intensified in recent times A sustained drive during the last decade has resulted in marked reduction of specific energy consumption by

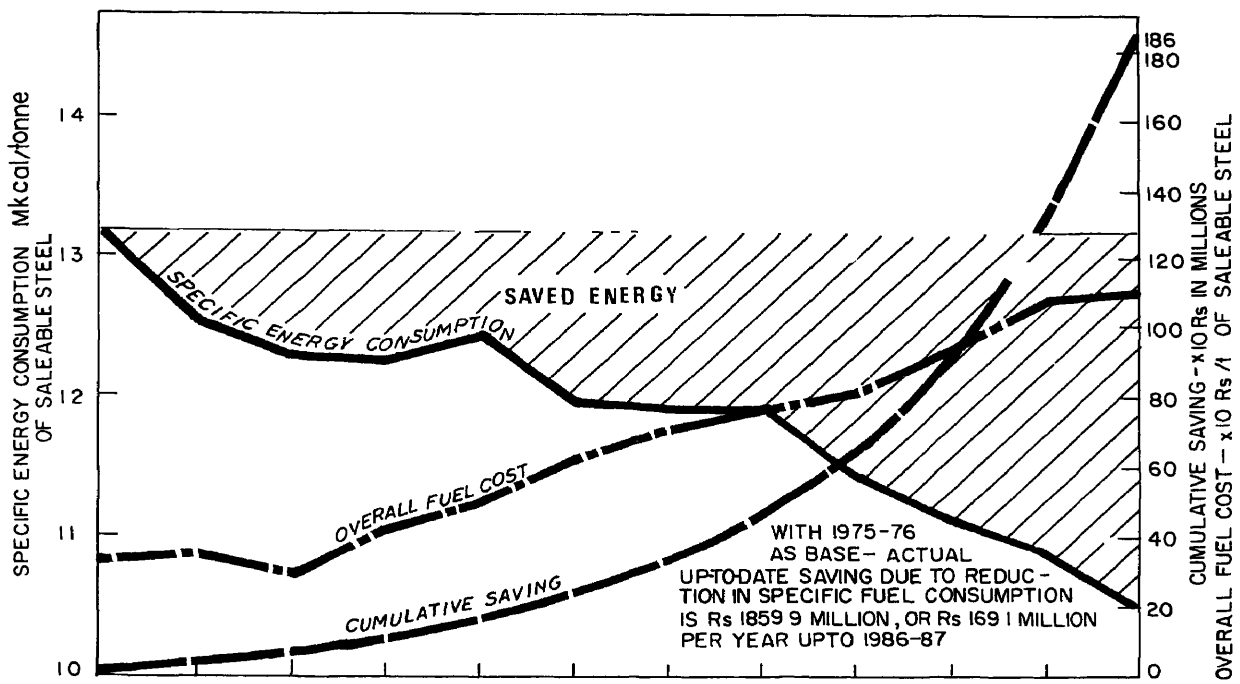


Figure 2 Reductions in overall specific energy consumption and cost saving 1975-87

* The specific energy consumption figures do not include energy consumption in iron ore mining operations and transportation of iron ore to the steelplants

23 5 per cent–from 13 17 Gcal/t saleable steel in 1975-76 to 10 52 Gcal/t saleable steel in 1986-87–an annual rate of reduction of 2 14 per cent The steady reduction in specific fuel consumption of the plant and the corresponding cost saving since 1975-76 are shown in Figure 2

The overall specific energy consumption was reduced by 8.6 per cent in the last five years, corresponding to a financial benefit of Rs 358 8 million on the basis of actual price of energy-mix Another important feature of the energy conservation programme was the reduction in expensive petroleum-based liquid fuels During the 5-year period ending in 1987-88, the input of petroleum products was reduced by approximately 25,124 t/year as compared to each of the preceding years

Approach to Energy Conservation

The energy conservation programme was launched in all sectors of the integrated steel plant with greater momentum after the first oil shock in 1973 A structured energy plan was formulated in 1980-81, as a corporate strategy using a multifaceted approach to improve energy efficiency and cut energy costs in different areas of production The energy plan had the following objectives

- Achieve an overall reduction in specific energy consumption at the rate of one per cent per annum, through saving of coking coal by economizing the use of coke in blast furnaces, minimizing use of petroleum fuels and improving operational efficiency in various process steps
- Optimize energy supply and consumption and plan future energy needs after taking into consideration the availability and impact of energy cost on the overall economics of operation
- Augment in-plant power generation to become self-sufficient in power for uninterrupted plant operation, leading to higher productivity and greater energy efficiency
- Introduce new energy-efficient technologies during modernization of the plant

Energy Conservation Strategies

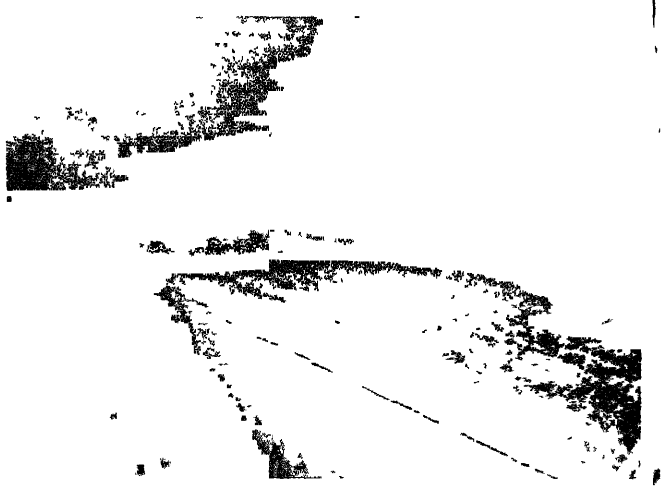
The major thrust in the energy conservation drive was towards improving operational efficiency, processes and productivity Steps were taken to improve production of raw materials at the Company's mines and collieries Other significant steps taken were control on recovery and distribution of by-product fuels and utilities in the plant, regular monitoring of fuel consumption, survey of thermal losses, control of thermal regimes of furnaces, periodic performance evaluation, and improvement of waste heat recovery equipment such as recuperators and regenerators

Concurrent with the energy conservation efforts in the existing production units/facilities, the on-going modernization of the plant, since 1983-84, has enhanced energy savings

Energy Management Methodology

The general principles of energy management were applied in various sectors and production units to identify key strategies as follows

- Identifying energy losses, eliminating wastage/leakages, and increasing productivity and process efficiency
- Introducing energy saving concepts and systems, with emphasis on waste heat recovery, and upgrading of combustion systems, refractories and other thermal insulation materials
- Creating awareness about efficient use of energy, and educating the workforce on shopfloors on energy conservation, through energy saving competitions, in-house training programmes, special courses and seminars
- Strengthening energy audit activities, monitoring of various process units/steps, and developing a computerized energy model for energy consumption data
- Building a cadre of technical staff for promoting energy-saving activities and coordinating energy conservation projects



View of sintering machine—equalization of bed temperature has been achieved by improving hood burners

An energy-saving competition is conducted for each department of the steel plant every month and the achievements are monitored For both fuel and electricity, specific energy consumption norms (also called the competition standards) are set for a six-month period and the actuals are recorded and reported Suitable corrective action is taken by the individual departments, if required

Management Structure for Energy Management

The Company's plant at Jamshedpur has a separate department exclusively devoted to energy management, called the Energy & Economy Department It was established in 1928, and has grown with the passage of time

The Department consists of experts in the field of energy management and instrumentation systems The total staff strength is about 300, comprising 15 officers, 10 senior supervisors–graduates in mechanical, chemical, electrical and electronics engineering with specialization in energy management and instrumentation An experienced and trained group of fuel and instrument technicians numbering about 100–graduates in science/ diploma in engineering with specialization in fuel technology–forms the basic manpower for energy conservation activities in the operating departments on the shopfloor This group is assisted by operators skilled in the energy conservation activities

The Department is placed on par with the production departments For effective management of the energy use there is horizontal interaction with the operating departments for day-to-day distribution, monitoring of efficient utilization, and accounting for all forms of energy used Also, it gives regular feedback on energy efficiency, specific energy consumption, and energy cost to all the operating departments and the senior management At the same time, the Department advises the management and the Engineering Division on energy conservation and energy management

Training

A multi-tier programme has been developed and is being followed to increase the energy conservation awareness amongst employees of the Company The salient features of the programme are as follows

- Advanced theoretical and practical training to employees working in the Energy and Economy Department
- Imparting training to all supervisors of the Company in the field of energy and general management at the Tata Management Development Centre, Jamshedpur
- All the departments are divided into a number of groups, each group taking part in the fuel rate and power rate competitions Awards are given to the group winner and the best employee of the group
- Poster and slogan competitions on energy saving are conducted and winners are suitably rewarded
- From time to time, thrust is given to energy saving by inviting suggestions from the employees under the Suggestion Box Scheme and doubling the reward value for suggestions in the area of energy conservation

Energy Conservation Measures

Some of the significant energy conservation measures implemented and the future conservation plan are briefly described in the following sections

Energy and Waste Heat Recovery

In an integrated steel plant, the potential for waste heat recovery, i e , recycling of waste heat in the process by recovery systems, such as regenerators and recuperators, is enormous At Tata Steel, since 1981, special attention has been given to this area As a result, new systems have been installed and several existing systems were revamped to improve thermal efficiency Some significant steps that have been undertaken are highlighted below

LD Gas Recovery System

The LD converter top gas is a waste product in the LD steelmaking process A recovery process based on the Japanese Oxygen Gas (OG) System was developed and installed in collaboration with Davy Mckee, U K , which is operational from November 1985 A schematic layout of the system is shown in Figure 3

The recovery potential of the system is about 60 million Nm^3 of LD gas per annum at the rated production of the LD Converter Shop This energy source will effect a fuel oil saving to the extent of 11,000 kL costing Rs 40.0 million at the present price of fuel oil

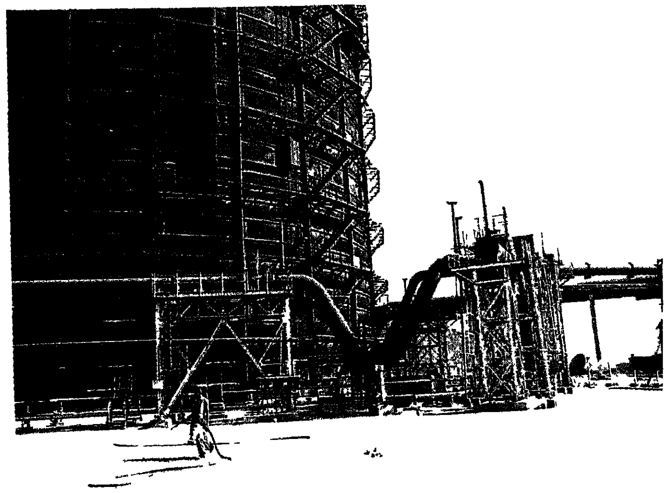
The actual savings of fuel oil, since the LD gas recovery system became operational, is about 2180 kL after 8 months of operation, despite some initial teething problems

Recovery and Utilization of Waste Nitrogen from Tonnage Oxygen Plant

The low pressure nitrogen, which was hitherto lost as a waste product, was put to the following uses by in-house engineering and erection/commissioning teams through a recovery, distribution and utilization system

- Top sealing of blast furnaces to replace steam sealing
- Sealing and purging of gas lines and electrostatic tar precipitation at the coke ovens
- Substituting atmos gas (made from fuel gas) for atmosphere control in the sheet annealing furnaces

The energy saving which resulted due to steam saving is worth Rs. 7 4 million per annum



Gas storage tank of L D gas recovery system

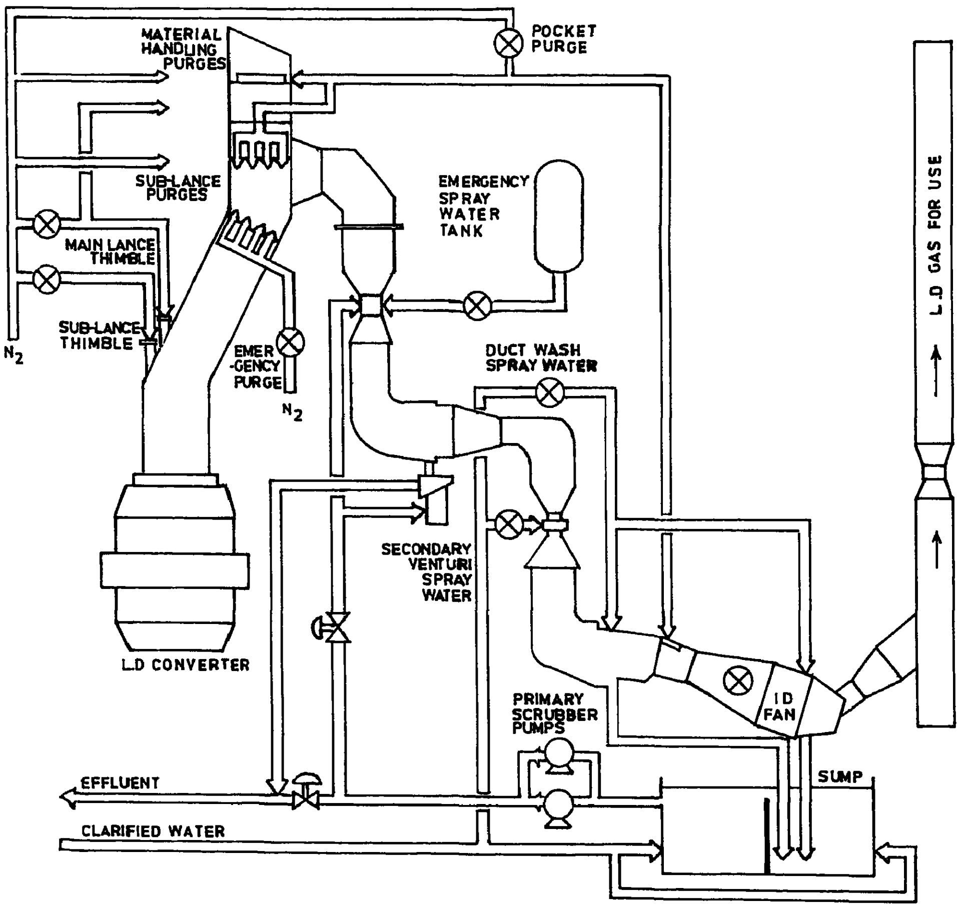


Figure 3 LD gas recovery system

Improving Recovery of By-product Coal Tar at Coke Ovens

Coal tar is used as a liquid fuel in the OH steel melting furnaces owing to its high calorific value, high C/H ratio (resulting in better flame luminosity) and low sulphur content, it is a direct substitute for low sulphur petro-fuels In the past few years, efforts were directed towards increasing the recovery of coal tar at the coke ovens The increase in yield was realized by means of the following measures

- Replacing and uprating of the by-product plant, with deep cooling of gases and electrostatic precipitation of fog
- Stricter control in plant operating parameters, and elimination of spillages and leakages

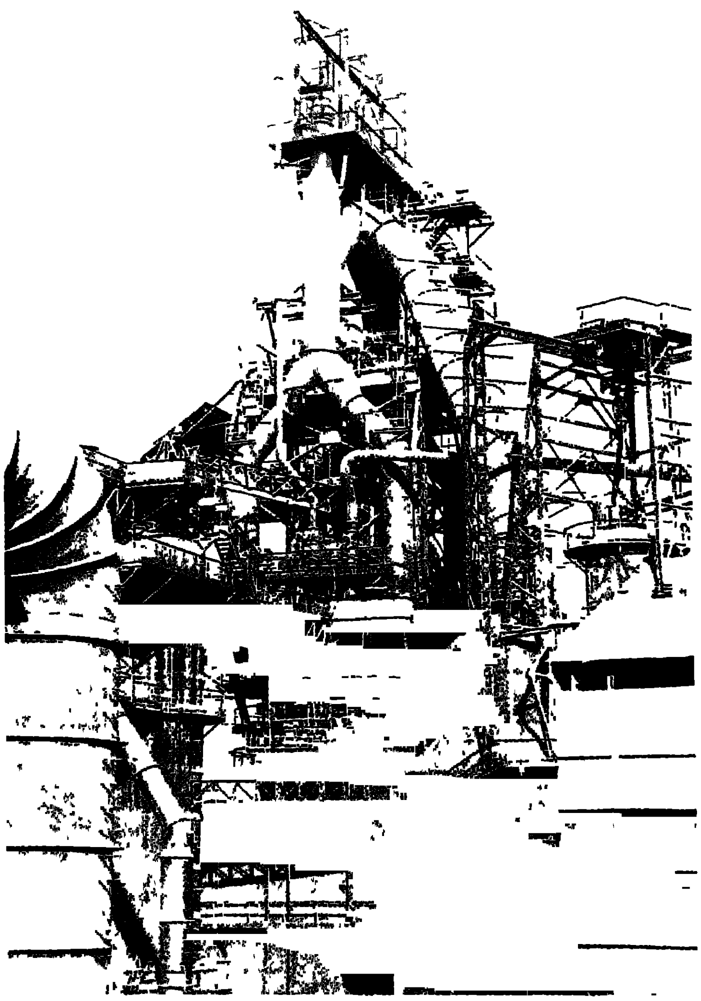
The progressive increase in coal tar yield from 1981-82 to 1986-87 was from 26 kg/t to 29 29 kg/t The cumulative savings were about Rs 91 million during this period

Increase in Hot Blast Temperatures at Blast Furnaces

A progressive increase in hot blast temperatures, by enhancing the use of blast furnance top gas in the existing Cowper's regenerative stoves, reduced the input of blast furnace coke The following significant steps were taken

- Modification of the existing combustion air fans and blast furnace gas supply lines, to increase the blast furnace gas firing rate in blast furnace stoves
- Checker work design changes, improvement in quality of refractories to withstand higher temperatures, and improved heat transfer
- Better instrumentation and control of combustion

Substantial energy saving in ironmaking was achieved with the increase in hot blast temperatures, introduction of automatic humidity control of blast, increased use of prepared burden, and technological improvements through rotating chutes and moving throat armour The cumulative saving from 1981-82 to 1986-87 is worth about Rs 100 million



View of blast furnace with variable throat armour

Improving and Optimizing Design of OH Furnace Regenerators

The thermal efficiency and keenness of OH furnaces are largely governed by the effectiveness of the regenerator checker work which recycles waste heat in the form of preheated air This increases the flame temperature and thereby accelerates heat transfer The increase in the thermal efficiency and keenness was achieved by

- Optimization of regenerator flue size
- Optimization of mass-area ratio
- Adoption of hydrojet cleaning
- Prevention of air leakage

The design modifications of the regenerator checker work carried out by TISCO are shown in Figure 4

As a result of the measures taken in the two OH furnace shops, which make about 1 2 Mt liquid steel per annum, the specific fuel consumption was reduced, by which expensive purchased liquid fuel (LSHS) was saved The cumulative saving from 1982-83 to 1986-87, was approximately Rs 160 million

Improving Waste Heat Recovery Systems in Mills, Soaking Pits and Reheating Furnaces

The improvement in the design of soaking pit ceramic recuperator increases the temperature of preheated

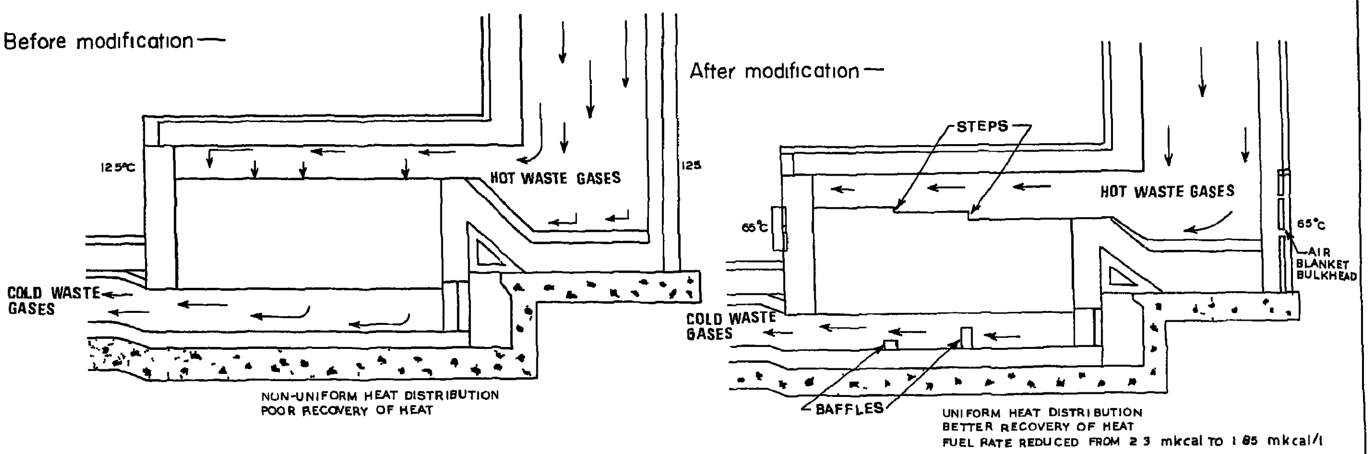


Figure 4 Modification to checkers—Steel Melting Shop No 1

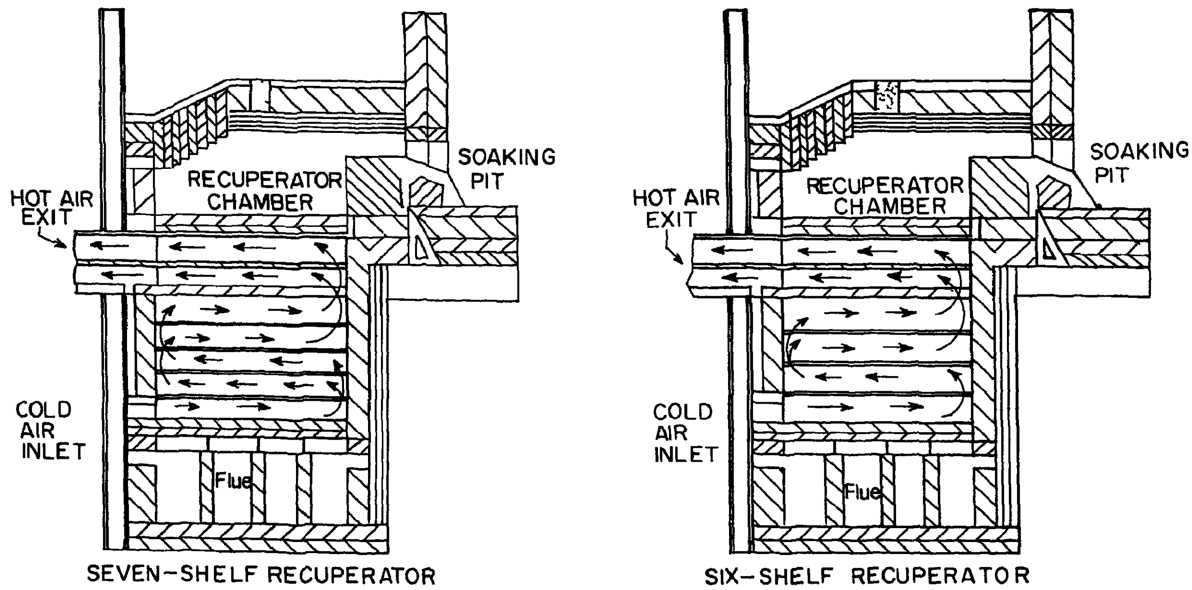


Figure 5 Rolling Mill No 2

combustion air (See Figure 5) Besides, improvement in insulation, sealing, and instrument controls were effected The cumulative saving in five years (ending 1986-87) amounted to Rs 240 million

Prevention of Energy Losses

Optimization of Process Distribution to Minimize Vent Loss

The oxygen produced at the tonnage oxygen plants is used in the LD Shop and SMS No 3 as energy source for steel production and process intensification The operating pattern of these two shops results in fluctuating demand against fairly constant level of production of oxygen Hence, it was essential to develop a control system for effective distribution of oxygen to the two shops to achieve effective utilization The salient features of the modifications which were done in-house are

- Interconnection with the two oxygen supply systems
- Control of oxygen supply to Secondary Consumer at a constant rate by installing a bypass automatic control system and an additional surge vessel
- Scheduling of oxygen production and distribution between LD Shop and SMS No 3, on the basis of operations research technique

By taking the above steps, the efficiency of oxygen distribution improved to a level of 92 per cent in 1985-86, resulting in a total saving of Rs 5 5 million

Process Steam Conservation

The techniques for steam conservation adopted for the widespread steam distribution network in the plant are

- Intensive regular survey of steam leaks, steam line insulation and steam trap condition
- On-line steam leak repairs

The conventional method of leak repairs is slow as it requires plant shutdown or isolation of steam line The on-line sealing technique is being used, since 1981, to accelerate leak repairs The benefits of on-line repairs are summarized in Table 3

A programme was started in 1983 to eliminate flanges, rationalize steam lines, and maintain and uprate steam traps, which are the source of leakage in the high pressure steam systems With a modest investment of about Rs 1 5 million from 1983-84 to 1986-87, steam leaks on account of repetitive leaky flanges in certain sections of the steam network have been substantially reduced The programme still continues The summary of benefits is given in Table 4.

Table 3. Benefits of on-line steam leak repairs

Year	No of Leaks Sealed	Approximate Steam Saved (t/year)	Annual Saving (Rs million)
1981-82 (Feb ' 82)	10	1,140	0 06
1982-83	315	36,220	1 99
1983-84	312	35,880	2 33
1984-85	163	18,750	1 50
1985-86	154	14,230	1 28
1986-87	250	23,345	1 87
1987-88	180	16,854	1 35
Total	1384	146,419	10 38

Table 4. Steam leak repairs by rationalization of steam lines, and elimination of flanges and welding

Year	Elimination of Leaky Flanges/ Joints	Rationalization of Steam Lines (m)	Approximate Steam Saved (t/year)	Annual Saving (Rs million)
1983-84	300	500	22,000	1 43
1984-85	387	1053	28,377	2 27
1985-86	—	425	25,000	2 38
1986-87	111	146	10,687	0 85
Total	798	2124	86,064	6 93

Steam Line Insulation—Uprating and Upgrading

The plant's steam network was surveyed extensively by an external consultant, and a major portion of steam lines has been insulated with better quality insulation This is an on-going programme in the plant for the past 7 years

Upgrading Thermal Insulation of Process Equipment

Uprating of Thermal Insulation of Reheating Furnaces

Uprating and introduction of back-up insulation in reheating furnaces and soaking pits, and application of ceramic fibres in reheating and heat treatment furnaces in the plant were undertaken as energy conservation measures Some of the typical examples of ceramic fibre applications are shown in Figures 6 and 7

BOX B

Iron and Steelmaking

The major process in production of iron is through blast furnace. However, since 1970, the role of direct reduction process in ironmaking has been significant in many countries abroad. The main difference between the two processes is in the operating temperatures. Blast furnace requires high temperatures to produce molten iron (hot metal) whereas at lower temperatures, solid sponge iron is produced in the direct reduction process Most of the iron produced in the world is used in the production of steel The remainder is converted to iron castings, ferroalloys and iron powder A simplified flow diagram of iron and steelmaking at Tata Steel is shown in Figure B 1

Ore Preparation. The major iron ore deposits contain iron in the form of oxides, such as hematite ($Fe_2 O_3$) and magnetite (Fe_3O_4) After physical separation of oxides from other constituents of ore, the iron oxide particles are obtained in the form of concentrates The fine particles in the concentrates are consolidated into hard pellets, sintered lumps, and briquettes to become suitable charge materials for the blast furnace or the direct reduction process

Hot Metal Production. Iron oxide is converted to metallic iron by application of heat and reducing agents The reducing agents, CO and H_2, are derived from coal, natural gas, and other carbonaceous or organic materials. The blast furnace uses coking coal (coke), which is charged at the top of the furnace Coke descends slowly into the furnace, where it is burned with hot air blasted through the tuyeres The molten iron at around 1400 °C from the bottom of the blast furnace is processed directly in the molten state or as pig iron molds in open hearth or basic oxygen furnace

Cokemaking. When coal is heated in coke ovens, in the absence of air, a fuel gas is released, leaving a residue of hard carbonaceous material called coke The gas released is primarily methane with small amounts of other recoverable organic compounds After processing, the residual gas is a useful fuel

Steel Manufacture Steelmaking consumes iron in the form of hot metal or pig iron molds Plants using their blast furnace product in this way are called integrated steel plants

Blast furnace iron provides only a portion of the metallic raw material for the steel industry The rest is obtained from scrap produced in subsequent manufacturing operations and from obsolete steel products

Though the melting point of pure iron is 1535 °C, to provide proper pouring conditions for both ingots and castings, in all steelmaking processes, the melt is generally raised to temperatures of 1550-1650 °C These high temperatures place serious limitations on the refractories that can be used They also require the most efficient use of heat, whether it is derived from combustion of fuel, electricity, or thermochemical reaction.

Chemically, all steelmaking processes are classified as acid or basic, depending upon the refractory and slag combination Each process has particular capabilities in the refining it can accomplish

Technologically, the current steelmaking processes can be grouped into two main types; (1) open-hearth and (2) electric. In open-hearth processes, the major source of heat is the combustion of fuel (usually gas or oil) In electric processes, the major source of heat is electric current (arc or resistance or both) The electric furnace is preferred or required for making of alloys, where oxygen concentration in the furnace has to be controlled. Electric furnace can operate in the presence or absence of oxygen, or even in vacuum

Basic Open-Hearth Process. Open-hearth furnace can be operated as either an acid or basic process by selection of refractories; in either case, a wide variation in practice is possible The open-hearth furnaces are operated continuously to conserve heat, minimize spalling of refractories and produce maximum tonnage

The solids, which are previously weighed into the charging boxes, are brought into the furnace area These boxes can be lifted, thrust through the furnace door and dumped by the charging machine Instead of solid charge, hot metal can also be poured into the furnace The mechanization of these operations is an essential feature of high tonnage rates

Electric Furnace. The electric arc furnace develops the required temperatures without the requirement of oxygen in the atmosphere Therefore, it is suitable for making alloys with oxidizable components like chromium, vanadium and tungsten As in the open-hearth, the solid charge of ore, limestone, scrap and pig iron is placed in the hearth after the previous heat has been drained and the bottom repaired The amounts of these materials depend on the specifications of the final product from the furnace

Use of Oxygen. In the conventional steelmaking processes, the use of oxygen is now well established Oxygen is

used for combustion in the open-hearth process to produce higher flame temperatures and develop heat faster, or to maintain an existing temperature pattern with lower fuel consumption For the purpose of blowing oxygen into the furnace, it is a common practice to insert an iron pipe (about 2 5 cm in diameter) through the charging door into the bath and to blow oxygen fast enough to cool the pipe and avoid excessive melting of the lance Roof lances are also used

In the KORF system in open-hearth furnaces, oxygen is injected about 200 to 300 mm below the slag layer, thereby improving bath agitation and reaction rates The benefits include decrease in fuel consumption by 50-55 per cent, reduction in tap-to-tap time by 50 per cent and reduction in specific oxygen consumption by 40 per cent

In electric arc furnace, the extra heat obtained with the oxygen lance makes possible the recovery of large amounts of chromium from stainless steel scrap

Basic-Oxygen Steelmaking. The best use of oxygen has been in what originated as the Linnz and Donnevitz (LD) Process, now generally referred to as basic-oxygen steelmaking. In the LD converter, pure oxygen is blown through a water-cooled lance, usually with multiple openings, into the top of the bath in a pear-shaped, basic-lined furnace The single source of oxygen makes the process ideal for automation

Casting of Steel. In the traditional casting of steel into various shapes as finished products, the ingots from the open-hearth, electric arc or LD furnaces are reheated in soaking pits to a temperature suitable for casting into bars, slabs, billets and blooms These are heated in reheating furnaces and cast into saleable products such as strips, plates, rods, bars, and sheets by means of pinch rolls

Continuous Casting of Steel. Instead of casting into large ingots, the molten steel can be fed through a water-cooled, reciprocating mold, and a solid rod, bar or slab extracted by pinch rolls This technique not only eliminates the scrap from cropping of ingots, but also avoids use of expensive fuels in the reheating of ingots and the intermediate products to produce finished steel products Moreover, use of expensive processing equipment such as soaking pits and blooming mills becomes unnecessary

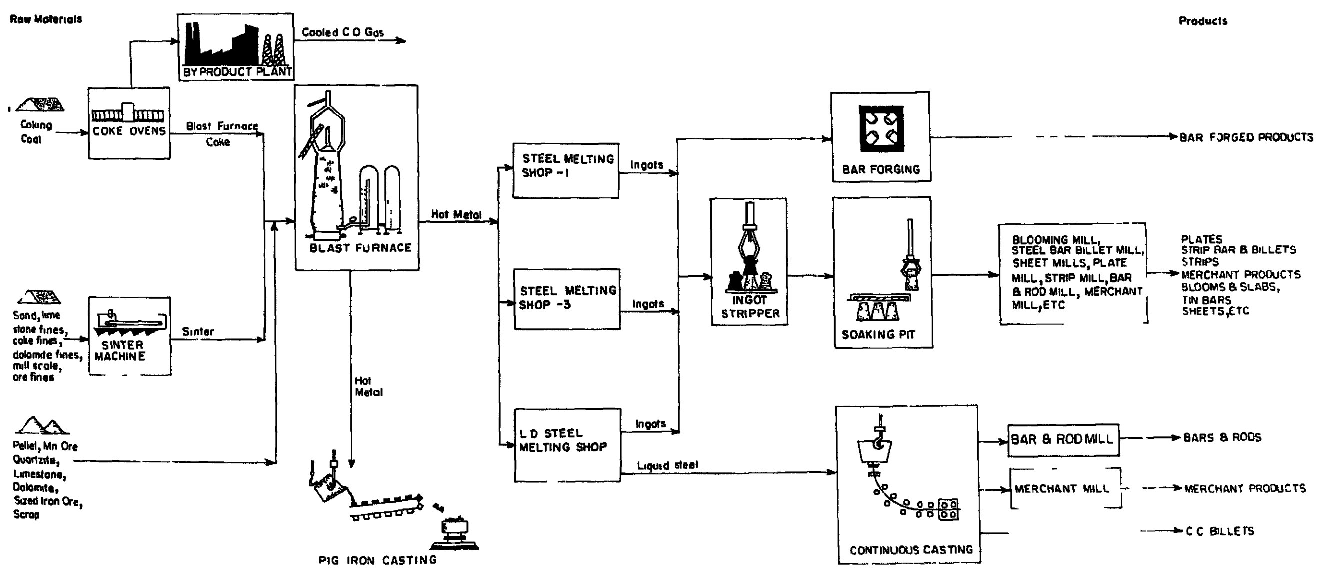


Figure B.1 Simplified flow diagram of iron and steel making at Tata Steel

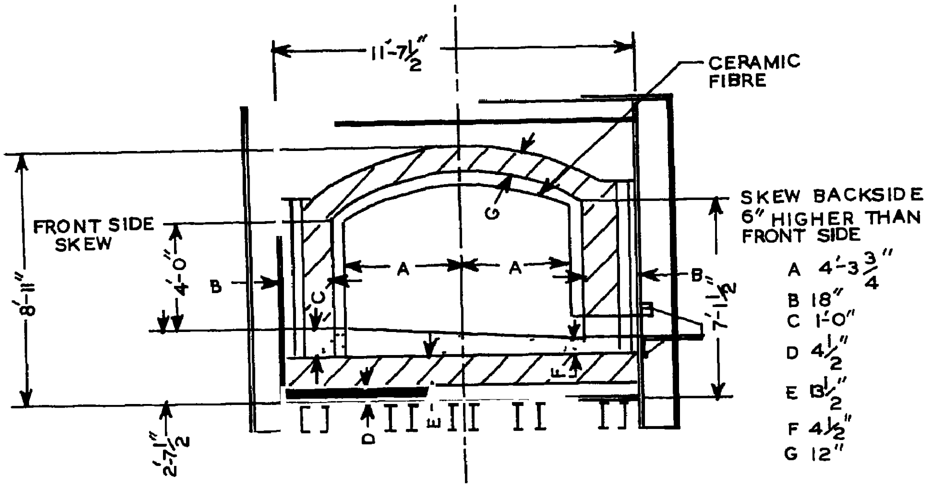


Figure 6 Plate mill furnace

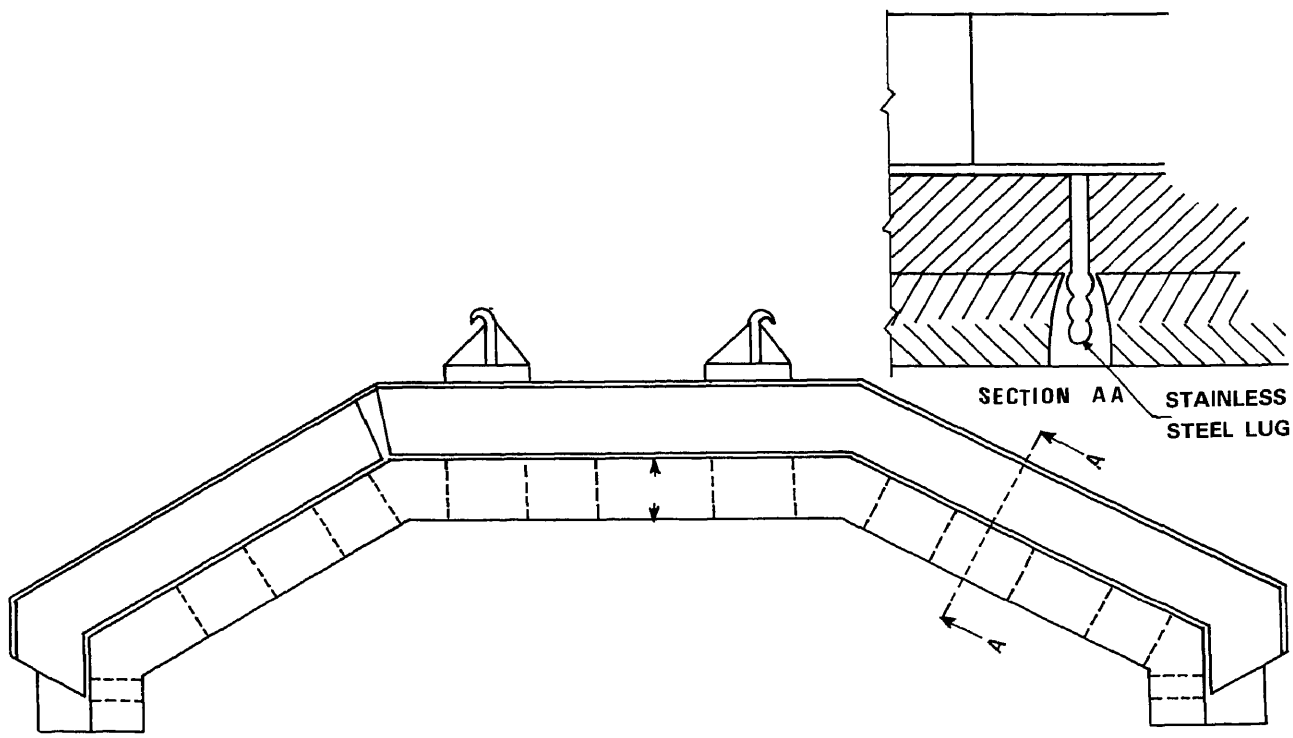


Figure 7 Ceramic fibre in circular furnace cover

Insulation of cold blast mains at blast furnace stoves

The cold blast mains (48 in to 54 in dia) were originally bare (i e , without any surface insulation) leading to heat loss by convection and radiation These mains carry air blast from turbo blowers, compressed at 1 4-2 1 kg/cm^2 (g) and at a blast temperature of 210°C. An insulation system was designed for all the six blast furnaces and implemented during the past 3 years The innovative measure improved the average hot blast temperature by about 12°C corresponding to a coke rate reduction of about 3 kg/t of hot metal (the cumulative saving was Rs 5 5 million up to 1986-87)

The insulation of blow pipes in the blast furnace has been initiated The energy saving potential of each insulated blow pipe is Rs 10,000 per annum and for all the blow pipes Rs 1 0 million per annum

The summary of the measures implemented with corresponding energy savings is given in Table 5

Table 5. Upgrading of thermal insulation of reheating and heat treatment furnaces by use of ceramic fibre insulation

Year	Furnace	Total Heat Saved (Gcal)	Annual Saving (Rs million)
1981-82	Sheet Mill Annealing Furnace-2	85	0 020
1982-83	Normalizing Furnace-2 No at Bar Forge & Tyre Mill	85	0 025
	Two Annealing Furnaces at Bar Forge & Tyre Mill	100	0 029
	Five Soaking Pits Cover Sealing	8000	2 400
1983-84	Circular Furnaces at Tyre Mill	25	0 008
	Steel Ladle Covers	78	0 023
1984-85	Plate Mill Reheating Furnace Ceramic Veneering	75	0 022
	Back-Up Insulation in Reheating Furnaces and Soaking Pits	2000	0 600
1985-86	Annealing Furnaces, L D Ladle Drier, Soaking Pits and Veneering of 60 t/h Reheating Furnaces	8000	2 400
	Total		5 527

Electrical Energy Conservation

Measures in Captive Power Generation Facility

The captive power generation facility at Tata Steel comprises two major power stations, viz , Power House (PH) No 3 and PH No 4

The boilers in PH No 3 were installed in 1938 and 1944, whereas in PH No 4 two boilers were installed in 1974 and one boiler in 1980 Boilers in PH No 4 operate at much higher pressure and temperature than those in PH No 3 The details of the equipment and the important operating parameters of the power houses are given in Table 6

Table 6 Details of captive power generation facility

Power House	Boilers	Date of Installation	Steam Pressure and Temperature	Power Generation Capacity	Fuel Used
No 3	No 1 & 2 (stoker-fired)	1938	32 kg/cm^2 (g) 370 °C	40 MW (total)	High volatile coal
No 3	No 3 & 4 (stoker-fired)	1944	32 kg/cm^2 (g) 370 °C		
No 4	3 no (pulverized fuel-fired)	1974 (Boilers No 1&2) 1980 (Boiler No 3)	63 kg/cm^2 (g) 480 °C	57 5 MW (total)	Middling coal, blast furnace gas, fuel oil

The average power requirement of the steel works is 120-135 MW The shortfall is made up by drawing power from Damodar Valley Corporation (DVC) and West Bengal State Electricity Board (WBSEB) up to a total of 120 MVA As the power supply from DVC (contract supply-100 MVA) has been very erratic, the Power Department has taken the following steps to minimize the shortfall

- Reduce downtime and increase availability of equipment
- Maintain boiler efficiencies at the highest possible level under the prevailing conditions

As in other industrial units, in recent years, Tata Steel has been facing problems of deterioration in the quality of high volatile coal due to increase in ash content from 16 per cent to 24 per cent Despite these constraints, the efficiencies and availability of the boilers have been kept at a high level

In PH No 3, the efficiencies of the old boilers have been maintained at around 70 per cent through a rehabilitation programme The Power Department has carried out replacement of critical pressure parts such as the Bailey water walls, and economizers and superheater tubes. The rehabilitation programme helped to maintain the efficiencies and eliminate forced outages, thus contributing to the improved fuel utilization and energy saving

In PH No 4, the forced outage rates have been held to a maximum of two per year for three boilers This has been made possible by the adoption of the following measures

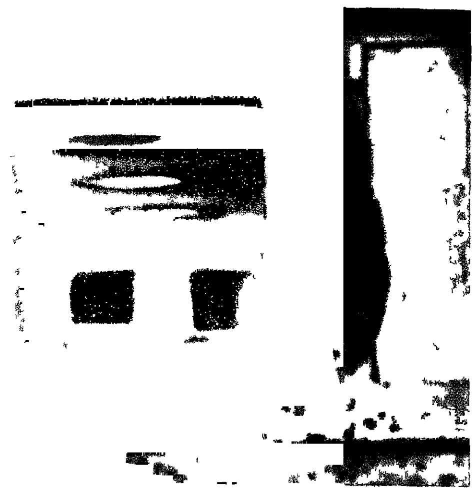
- Steady improvement in water quality
- Protection against erosion of critical pressure parts in the flue gas path
- Change in material of the attemperator spray pipes
- Improved inspection procedure during overhaul

The installation of an axial-flow turbo blower in 1981-82 brought about substantial steam saving As compared to the conventional centrifugal turbo-blowers for blast furnaces, the axial blowers have higher efficiencies As a result, there has been a reduction in the steam rate by about 5-6 per cent This quantity of steam has been used for the increased power generation at PH No 4

Use of on-line steam leak repair methods has also resulted in steam saving and its increased availability for power generation

Other Electricity Conservation Measures

- Fuel oil consumption in Boiler No 1 and No 2 at PH No 4 was brought down from 250-300 kL per month to 80 kL/month This was achieved by optimizing fuel oil pressures at the burner head from 10 4 kg/cm^2 (g) to 6 kg/cm^2 (g) by using orifices of appropriate sizes in the individual fuel lines It was ensured through simulation that there was no flame destabilization during any of the adverse furnace conditions.
- Waste heat utilization through waste heat boilers in the OH furnaces of SMS No 3 steadily improved with better tube cleaning methods, chemical cleaning, improvements in water quality and timely replacement of tubes This resulted in increase in steam generation from 3 94 t/boiler/h to 5 43 t/boiler/h between 1979-80 and 1987-88
- Capacitors for power factor improvement were installed at PH No 3, Bar & Rod Mill and the new sinter plant
- Switching over from 600-series steel mill duty motors to 800-series motors with F and H class insulation
- Solid state variable speed drives were installed on a c motors and closed loop control was installed on d c motors (See Box D for details on energy-efficient motors)
- At the Merchant Mills, conversion from mercury arc rectifiers to thyristor drives is in progress The thyristor drive is much more energy-efficient than the mercury arc rectifier and its control Four 400-kW mercury arc rectifiers have been replaced so far The approximate saving is 30,000 kWh/a
- Incandescent bulbs in the office buildings were replaced by fluorescent lamps, and for street lighting, sodium vapour lamps were installed The saving in power was approximately 800 kW



Flat flame burner—burners with advanced technology for walking hearth furnace at Bar & Rod mill

Energy Saving in Oxygen Plant

Two 250 tonnes-per-day oxygen plants were commissioned in 1983 From 1984-85 to 1987-88, the specific power consumption in the oxygen plants was brought down from 621 kWh/t oxygen to 554 kWh/t oxygen At the present level of production of 489 t/day, the net power saving amounts to 12 million kWh/day

The measures taken to effect the above reduction in electrical energy are as follows

- The oxygen system pressure was reduced from 42 kg/cm^2 (g) to 16-35 kg/cm^2 (g) by letting the compressors operate on the consumer line pressure and removing the control valve The reduction in the system pressure was required to eliminate high machine vibrations in the compressors The lower compression ratio was responsible for an additional power saving The net power saving is approximately 8400 kWh/day

- The existing liquid oxygen pumps are oversized The original design included a recirculating line to the liquid oxygen storage tank, resulting in flashing into gaseous oxygen The loss of oxygen due to flashing was avoided by installing flow restriction orifices in the delivery lines of the liquid oxygen pumps, which enabled reduction in the pumping rate to match the downstream requirements

Other Measures

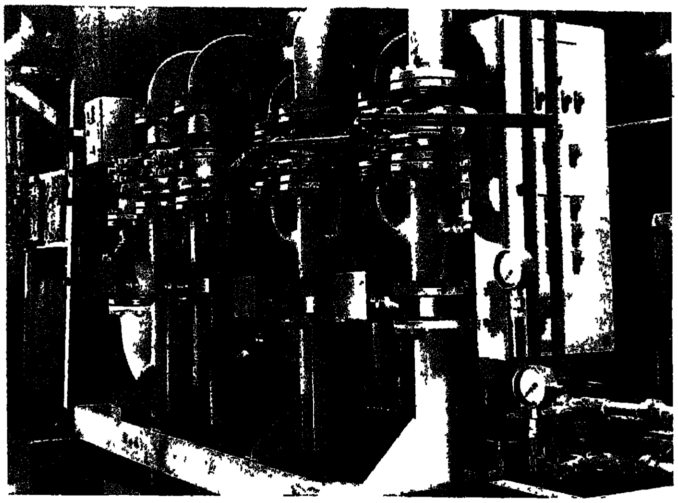
Computerized Energy Model System for Energy Consumption Monitoring and Management Control

All the steel plant processes are highly energy-intensive, where multiple energy sources are used Regular monitoring of energy supply and consumption is a prerequisite for an energy conservation programme

Manual calculation and compilation of energy consumption norms are time consuming and are prone to errors Hence, a computer terminal was installed in the Energy & Economy Department, and a computerized energy calculation model was developed and put into operation since 1984-85

KORF Oxygen Process in OH Furnaces at SMS No 3

Oxygen lancing of molten steel bath in OH furnaces as a process of intensification to increase productivity and reduce energy consumption is a well established practice Encouraged by the enormous energy saving potential of KORF process which involves submerged oxygen injection in OH process, Tata Steel entered into an agreement with KOTEC AG, Switzerland, to acquire the know-how of KORF technology Work on implementation in two of the eight OH furnaces was completed in mid-1987 The benefits in terms of energy savings are as follows.



Valve stand and tuyer assembly in KORF furnace at Steel Melting Shop No 3

- The average fuel rate in OH furnaces will decrease from 725 kcal/kg to 315 kcal/kg crude steel
- Total heat working time will be 4 h 35 min instead of 9 h 30 min
- Reduction in oxygen consumption by about 8 m^3/t of crude steel
- Extra generation of 152 t/day of steam from the waste heat

Figure 8 displays the energy conservation potential of OH furnaces with the application of KORF technology

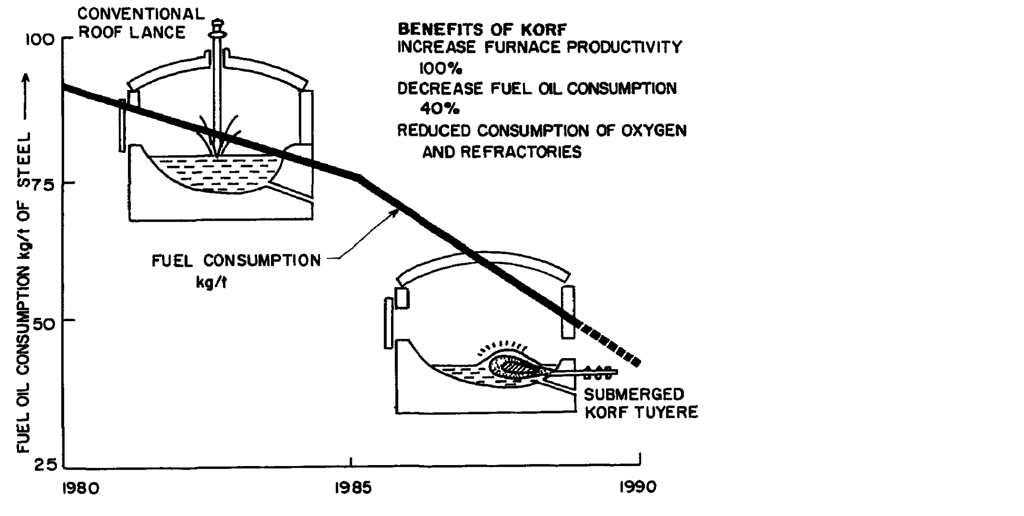


Figure 8 KORF technology for efficient fuel and oxygen utilization in open hearth furnaces

BOX C

Stamp Charging Technology*

One of the major problems faced today by Indian steel plants is the comparatively inferior quality of blast furnace coke. The reserves of coking coal in the country are limited, and those of prime coking coal even less. To conserve the scarce resources of coking coal, the coke ovens of integrated steel plants are not only to be geared to use coal having higher ash content but also to use inferior grades of coal. Blast furnace coke must conform to specified strength properties generally indicated by its M_{10} index to withstand the rigours of the blast furnace conditions without disintegrating into fines

The strength of coke is commonly measured and monitored by its resistance to degradation in terms of M_{40} index and abrasion resistance in terms of M_{10} index Good quality blast furnace coke is characterized by high M_{40} index (over 78) and low M_{10} index (less than 10) Blast furnace productivity is influenced to a considerable extent by the strength of coke Therefore, integrated steel plants aim at optimum coke strength, by appropriate choice of the coal blend However, under Indian conditions, there are constraints on this due to scarce prime coal reserves, and hence, besides optimum blends, other technological process improvements also need to be incorporated Various precarbonization processes have therefore been developed, of which the following three technologies are the most important ones

- Briquette blending of coal using tar and pitch
- Preheating of coal
- Stamp charging of coal

Briquette blending is being used with success in many plants abroad. However, in the case of Indian coals, work carried out in the R&D Division of Tata Steel has conclusively shown that the process requires use of binder (pitch) which is not only costly but also not freely available in the country

Preheating of coal, though most desirable for improving the M_{10} index of coke, has been almost completely abandoned because of operational hazards and maintenance problems associated with such installations

Salient Features

Two parameters are crucial to the success of stamp charging These are the relatively higher crushing fineness of coal and its moisture content. Coal has to be crushed to around 90% below 3 15-mm size, against 80% for conventional charging and the moisture content of coal is maintained at 8-10 per cent as against 5-7 per cent for conventional top charging to ensure optimum coke strength and bulk density

Crushed coal is stamped in the form of a cake outside the oven by means of a massive stamping unit mounted on a combined stamping-charging-pusher machine. In a top charged battery, there is need only for a pusher car, since crushed coal is gravity charged from the oven top. The stamping unit consists of a box with vertical free falling hammers operated by electric motors for stamping finely crushed coal into a cake The timing and sequence of fall of the hammers are critical to get adequate cake density and strength Stamped coal cake, which almost conforms to the inner dimension of the oven, is then charged into an empty oven through the ram side door

As an atmospheric pollution control measure, a Charging Gas Car (CGC) is provided on the top of the battery to suck out the gas generated during charging, burn the combustible gases, clean it in wet scrubbers and release it to the atmosphere with dust content within the permissible limits

Stamp charging process is not new and has been in operation for several decades in West Germany (Searland), France, Poland and Czechoslovakia, where good coking coal is not available However, the older generation stamp charging and pushing machines were slow and primitive in design Saarberg Interplan, West Germany, during the last decade, have developed an improved design of this machine which gives higher bulk density of cake and works at double the operating cycles per day compared to the older machines

Advantages

Extensive laboratory and pilot plant tests have been conducted on coal blends used at Tata Steel both at Saarberg Interplan and at the R&D Division of Tata Steel Saarberg Interplan have also carried out the feasibility study on the adoption of this technology at Tata Steel Test results have indicated the following benefits of stamp charging as compared to the conventional top charging, installed in a coke oven battery of identical size

- Increase in coal throughput by over 12 per cent as a result of increased bulk density of stamped cake (1150 kg/m^3 against 820 kg/m^3 in case of conventional top charging)

* Extracted from the article-Irani, J J, "Stamp Charging Technology", Tata Tech (Tata Steel), December 1987

- Increase in blast furnace coke yield by about 3-4 per cent
- Improvement in M_{10} index of coke by 2 points and in M_{40} index by 3-4 points
- Coke strength less sensitive to changes in coal blend and the possibility to use somewhat inferior grades of coal, if the necessity arises

These will give the following advantages in steel plant operation

- Higher productivity in coke ovens because of increased coal throughput and higher blast furnace coke yield
- Better blast furnace operation as a result of higher availability of coke of superior quality
- Optimum coke rates due to consistent coke strength
- Consistency in coke could improve iron chemistry with possibly lower silicon content of hot metal, provided the ash content of coke is firmly regulated

Plans at Tata Steel

Tata Steel is introducing the stamp charging technology in its Works The work includes secondary coal crushing facility for finer grinding, installation of stamp charging and pushing machines and charge gas cleaning car and related infrastructural facilities Additional capital cost for introducing Saarberg Interplan's stamp charging technology in one battery of 54 ovens compared to top charged battery, is estimated to be about Rs. 300 million The benefits outlined earlier justify the additional investments by assured economies in downstream operations in an integrated steel plant, particularly in iron-making in blast furnaces

Based on the experience of Tata Steel in the new battery, stamp charging may be adopted in sequence while rebuilding other batteries

The stamp charging process is operating successfully in many steel plants abroad and it also imparts significant improvement in the M_{10} index of coke, even while using relatively inferior coal blends Indian coals have shown encouraging results with the use of this technology After conducting extensive laboratory and pilot oven tests with this technology, to establish conclusively the substantial benefits, Tata Steel has opted for this technology, starting with its new coke oven battery now under construction

Quantification of Energy Saved

The data on energy saved during the past 7 years is shown in Table 7

The energy saved represents approximately 8 8 per cent of the total energy used The saving has made significant contribution to the Company's profitability

Table 7 Energy savings from 1975-76 to 1986-87

Year	Overall Fuel Rate (Gcal/t ss*)	Difference Over Base Value (Gcal/t ss*)	Gross Production (Mt ss*)	Saving in Heat (10^3 Gcal)	Saving in Heat (10^3 toe)	Cumulative Monetary Savings (1975-76 rupee equivalent) (Rs million)
1975-76	13 17	—	—	—	—	—
1980-81	12 00	1 17	1 537	1798	179 8	241 3
1981-82	11 98	1 19	1 606	1911	191 1	355 9
1982-83	11 99	1 18	1 621	1913	191 3	481 9
1983-84	11 50	1 67	1 626	2716	271 6	674 9
1984-85	11 15	2 02	1 714	3462	346 2	960 6
1985-86	10 97	2 20	1 772	3899	389 9	1341 1
1986-87	10 52	2 65	1 907	5055	505 5	1859 9
1987-88	10 93	2 24	1 914	4287	428 7	2344 2

* s s—saleable steel

Investment in Energy Conservation

Table 8 shows the investments made in the past 7 years and cumulative savings on various energy conservation projects

It may be noted that the total investments during 1981-87 were about Rs 210 25 million, which is about 5 per cent of the total investments during this period

Dual-fuel burner for rotary kilns—commissioned by TISCO engineers

BOX D
Energy-Efficient Motors

Between 1910 and 1970, the tendency in the designing of electric motors was to reduce the weight and size per kW-rating of the motor This was possible because of development of low-loss magnetic material and high temperature insulating material. Moreover, historically, electric motors, particularly those in the range of 1-250 hp, have been designed for minimum first cost. This was achieved by providing the least amount of active material, i e., laminated steel, copper or aluminium wire, and rotor aluminium wire, necessary to meet the performance requirements. Though the weight, size and hence, the initial cost of the motor reduced drastically, the efficiency of the motor suffered However, this trend reversed in the early seventies.

Unfortunately, there is no single definition of an energy-efficient motor Similarly, there are no efficiency standards for NEMA* design B polyphase induction motors Standard motors were designed with efficiencies high enough to achieve the allowable temperature rise for the rating. Therefore, for a given hp rating, there is cosiderable variation in efficiency

In 1974, one electric motor manufacturer in the U S examined the trend in increasing energy costs and the costs of improving electric motor efficiencies The cost/benefit ratio at that time justified the development of a line of energy-efficient motors+ with losses appro ximately 25 per cent lower than the average NEMA design B motors.

Energy-efficient motors incorporate design improvements to reduce intrinsic motor losses Designs of such motors have a greater content of active materials, use

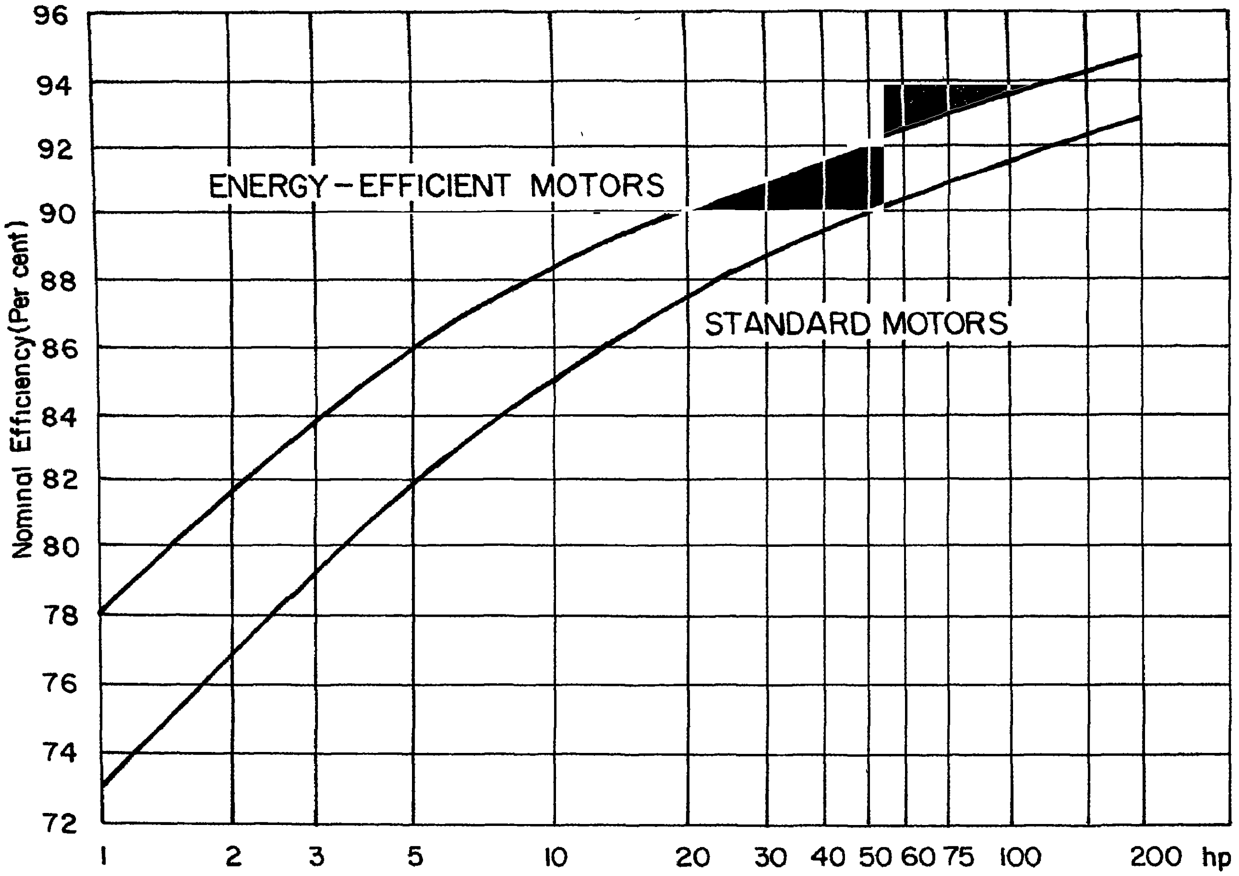


Figure D.1 Nominal efficiencies of NEMA design B four-pole motors, 1800 rpm. stardard versus energy-efficient motors.

* NEMA— National Electrical Manufacturers Association, U S A

\+ At present energy-efficient motors are not made in India These have to be imported from Western countries

superior quality materials, and require stricter quality control in machining and manufacturing operations As a result, costs of energy-efficient motors are about 10-30 per cent more than those of standard motors

Figure D 1 shows a comparison of the nominal efficiencies for NEMA design B four-pole motors at 1800 rpm (standard) with those of energy-efficient motors, for a range between 1 hp and 200 hp

The figure shows that the range in efficiency for energy-efficient motors is considerably less than that of standard motors, and that the efficiency difference between standard and energy-efficient motors decreases as motor size increases

The selection of an energy-efficient motor should be based on several factors additional to those for a standard motor

1 Electric power-saving and life-cycle-cost comparison to standard motors
2 Improved ability to perform under adverse conditions such as abnormal voltage (Generally, the energy-efficient motors have superior performance characteristics under abnormal voltage conditions)
3 Lower operating temperatures
4 Noise level
5 Ability to accelerate higher-inertia loads than standard motors
6 Higher operating efficiencies at all load points (At all loads, the energy-efficient motor presents the opportunity for energy savings)

In certain applications and duty cycles, energy-efficient motors cannot be justified on the basis of energy saved, for example,

a Intermittent duty or special torque applications

- Hoists and cranes
- Traction drives
- Punch presses
- Machine tools
- Oilfield pumps
- Fire pumps
- Centrifuges

b Types of loads

- Multispeed
- Frequent starts and stops
- Very high-inertia loads
- Low-speed motors (below 720 rpm)

In general, energy-efficient motors can be justified on a payback basis because of the annual saving of electric energy. This saving is a function of the hours of operation per year and kilowatt-energy reduction In favourable situations, payback periods of less than one year can be obtained, typical payback periods are less than two years Usually motors operating for less than 2000 h/a are not good candidates for replacement by energy-efficient motors

Use of Non-Conventional Energy Sources

Solar Heating System for LSHS Fuel Oil*

Inherently, steelmaking requires high temperatures and needs high grade energy sources–coal, fuel oil and electricity However, at Tata Steel, a pioneering effort was made in May 1982 to use solar heating system in place of steam heating for preheating LSHS up to 70-75°C in LSHS transit storage tanks, and also to supply preheated feed water to boilers for improving thermal efficiency

Economic Benefits

Heat recovered by the solar heating system is approximately 1 2x10^6 kcal/day, on a 5 h/day working basis The saving due to the solar heating system is about 200 kL furnace oil/year costing Rs 0 5 million

* LSHS—Low sulphur heavy stock

Energy Conservation Plans and Targets for Future

Having achieved in the first 5 years the target set in 1980-81 which was 10 per cent reduction in the specific energy consumption (in 10 years), the Company has formulated its Energy Management Plan for 5 years beginning 1985-86 The new goal is to maintain an annual rate of reduction of 2 per cent and reduce specific energy consumption to less than 8 75 Gcal/t crude steel

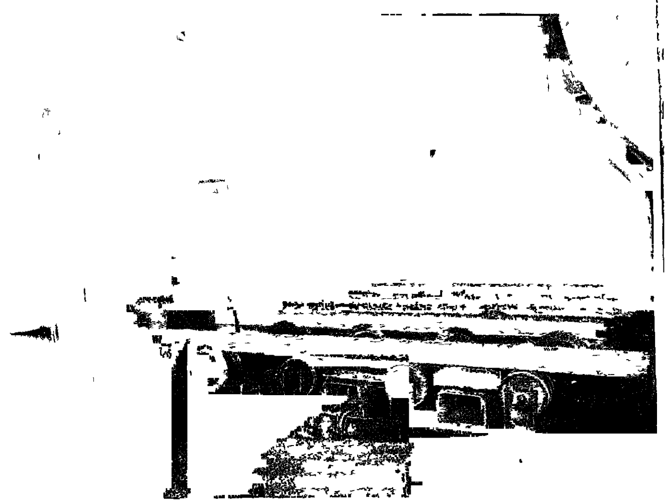
The main areas covered under the second phase of the energy conservation plan are given below.

Stamp Charging

Stamp charging is a precarbonization technology for improving the quality of coke produced from a given blend of coal Tata Steel is introducing this technology in

Table 8. Direct investment in energy conservation during 1981-87

Energy Conservation Areas	Total Investment (Rs Million)	Cumulative Savings (Rs Million)
Steam leaks, rationalization and insulation	5 50	6 60
Cold blast main insulation at blast furnaces	1 00	1 20
Insulation of LSHS storage tanks	0 15	0 12
Improvement in insulation in soaking pits, reheating furnaces, use of ceramic fibres	2 00	1 80
Improvement in oil firing equipment and high efficiency burners in reheating furnaces and forge furnaces	2 00	3 00
Improvement in blast furnace stoves for higher hot blast temperature	10 50	12 60
Soaking pit recuperator design changes	1 50	1 00
Improvement in furnace and energy distribution, instrumentation for energy conservation	38 00	45 60
LD gas recovery system and concast	140 00	390 10 (2 yrs)
Utilization of waste LP nitrogen for steam savings	7 00	5 60 (4 yrs)
Solar heating system for LSHS heating	0 45	0 41
Portable energy monitoring devices	1 50	1 35
Energy promotional activities including inter-department competition	0 65	0 78 (Estimated)
Total	210 25	470 16



Six-strand continuous billet casting machine

its Works The system includes two stamp charging and pushing machines, and a charge gas cleaning car The machines are currently under installation (See Box C for details on stamp charging technology)

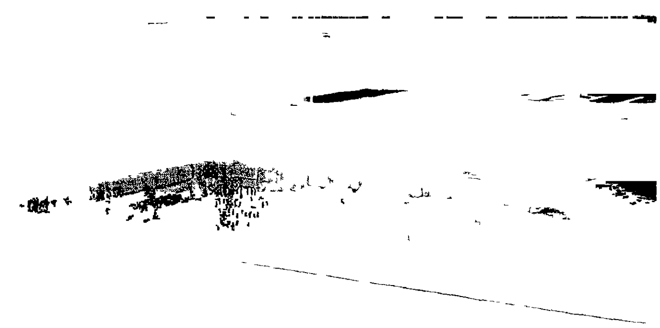
Ironmaking

Reduction in the coke rate in blast furnaces from the present level of 745 kg/t to 685 kg/t by beneficiation of iron ores and coal inputs

Increase in the proportion of sinter in blast furnace burden by installing another sinter plant

Steelmaking

About 50 per cent of the liquid steel is produced by open-hearth process which consumes about 75 kg/t of fuel oil under optimum operating conditions



Corrugated wall in soaking pit for better heat distribution

n order to reduce energy consumption, it is planned to ıtroduce KORF technology in all the open-hearth urnaces This will reduce the oil consumption by about l0 per cent

Steel Rolling

The old reheating furnaces at several mills will be eplaced by new efficient furnaces with high efficiency urners, improved refractories and recuperators The verall objective is to improve thermal efficiency from he present level of 40 per cent to over 60 per cent

Captive Power Generation

The captive power which has been augmented from 70-MW to 85-MW level during the the past 7 years will e further increased to 120 MW by the turn of the ecade

Conclusion

At Tata Steel, energy conservation has been a way of life for well over half a century, though the efforts were greatly intensified in recent times Owing to a well structured energy conservation plan, a sustained reduction in energy consumption by over two per cent every year since 1975-76 has been achieved The multifaceted approach adopted by Tata Steel includes not only technical measures but also managerial aspects Here is a good example of a large plant with old machinery and equipment which has achieved singnificant improvement in energy efficiency This would not have been possible without modernization drive, worker participation, good housekeeping, regular energy audits and targets, training and awareness campaigns, and well thought-out investment plan

For further information, please contact

The Superintendent
Energy & Economy Department
Tata Iron & Steel Company Limited
Jamshedpur-831 001

TERI Publications

ASSET—The Documentation and Information Centre has now been entrusted with the responsibility of publishing the Abstracts of Selected Solar Energy Technology (ASSET) on behalf of the United Nations University, Tokyo

Annual subscription : US$ 80 (by airmail) and US $ 50 (by surface mail).

Discussion Papers—These are a series of in-house research papers So far, 29 papers have been written on different aspects of energy Price available on request

Energy Digest—A bi-monthly (6 issues a year) publication which includes reviews and digests of international advancements in the area of energy systems and technologies It also provides indicative abstracts of important and current microdocuments, besides giving news items and a calendar of events

Annual subscription: Rs 100/-(India); US $ 20 for developed countries and US $ 10 for developing countries (both by airmail).

Energy-Environment Monitor—A bi-annual (2 issues a year) journal which contains abstracts, reviews and current literature survey as well as original papers, concentrating mainly on energy-environment issues This journal is produced under the Govt of India's programme of information on environment, called the Environment Information System (ENVIS) Subscription details available on request

Energy Policy Issues—An annual publication, this is a compilation of the proceedings of the Workshop on Energy Policy Issues held every year at Jaipur The participants in this Workshop are top-level officials working in India's energy sector and selected specialists from India and abroad

Price: Rs 150/-(India) and US $ 25 (by airmail).

Indian Energy Abstracts—A quarterly abstracting journal highlighting current research and development in the Indian Energy field, suitably classified and arranged by subject

Annual subscription : Rs 65/- (India); US $ 25 for developed countries and US $ 10 for developing countries (both by airmail).

Industrial Energy Conservation-Case Study Series—Published periodically, the series is an attempt to bridge the information gap between successful attempts at industrial energy conservation in one company and their repetition at many more sites elsewhere Each number in the series covers the study of energy utilization and measures taken to improve it in one company So far, four issues have been published Price available on request

Mycorrhiza News—The first of its kind in Asia, this quarterly Newsletter provides a forum to experts, scientists and researchers in different parts of the region for presenting their views and findings on Mycorrhiza

Annual subscription· US $ 40 for developed countries (by airmail) and free of cost to developing countries.

Pacific and Asian Journal of Energy (PAJE)—The inaugural issue of this international journal was brought out in March, 1987 Initial periodicity of the Journal is bi-annual with a provision for subsequently making it a quarterly

Annual subscription Rs 225/- (India), US $ 50 (by airmail) and $ 40 (by surface mail)

Tata Energy Data Directory and Yearbook (TEDDY)—This widely disseminated annual publication is based on the latest energy data collected for different sectors of the Indian economy with selected international energy statistics

Price: Rs. 100/-(India); US $ 40 (by airmail) and US $ 30 (by surface mail)

SESI Journal—This Journal is produced by TERI as a service to the Solar Energy Society of India The Journal, available by membership as well as subscription, covers all aspects of renewable energy, including basic science, technology, policy, economics, extension and field monitoring issues

Annual Subscription Rs. 150/- (India), US $ 24 (by airmail) and US $ 15 (by surface mail)

SESI Newsletter—This is a quarterly current awareness service which complements the SESI Journal It reports recent activities of the Society, research in progress, news briefs and events in the renewable energy area

For further information please contact

Co-ordinator
Information Systems
Tata Energy Research Institute
7 Jor Bagh
New Delhi-110 003
India